

(12) UK Patent Application (19) GB (11) 2 212 679 A (13)

(43) Date of A publication 26.07.1989

(21) Application No 8803203.2

(22) Date of filing 11.02.1988

(30) Priority data

(31) 8726783

(32) 16.11.1987

(33) GB

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(51) INT CL⁴

H02H 3/093 // H02H 5/04 7/08

(52) UK CL (Edition J)

H2K KHB KSD1X K234 K252 K452 K512 K76Y
K765 K768
U1S S2049

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(58) Field of search

UK CL (Edition J) H2K KCX KHB KJE KSD1X
INT CL⁴ H02H

(54) Overcurrent circuit breaker with time delay

(57) An overcurrent circuit breaker for an electric system eg. an induction motor M, has a timer TM which produces a first control signal a1 a predetermined time after the system is turned on, and a load detector CT in association with an overcurrent control device VR which produces a second control signal a2 when the load applied to the system exceeds a predetermined level. The first and second control signals jointly activate an amplifier AMP to produce a third control signal a3 which activates a microrelay MR1 and a power relay PR to cause a magnetic switch MG to open, or trip, whereby the system is turned off. The time delay allows a current surge in the system to occur without causing the magnetic switch to trip during a starting period. The system may also be tripped by a thermal detector TH acting through a second microrelay MR2.

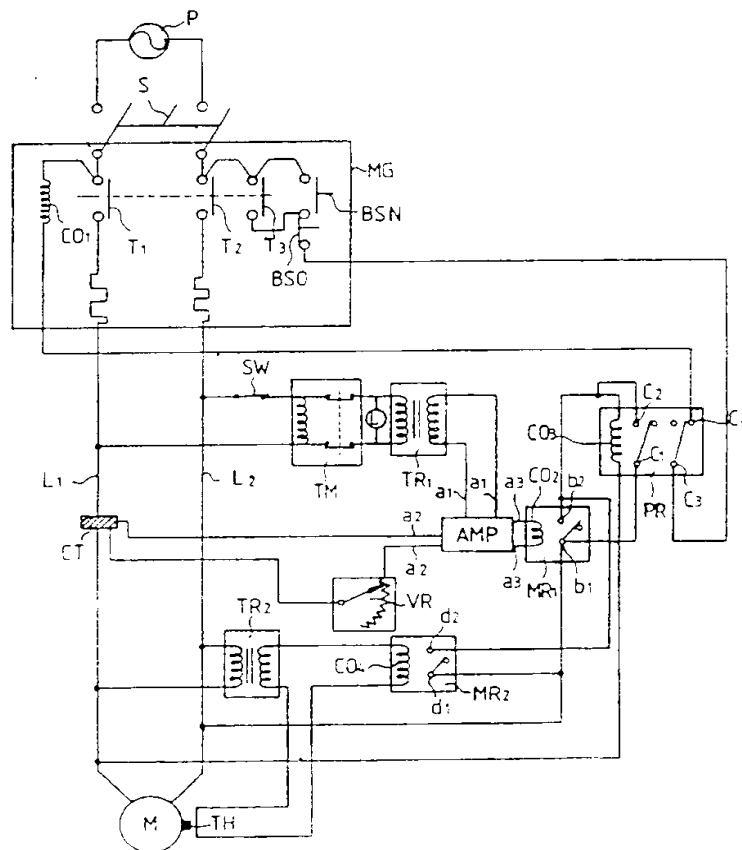


FIG. 1

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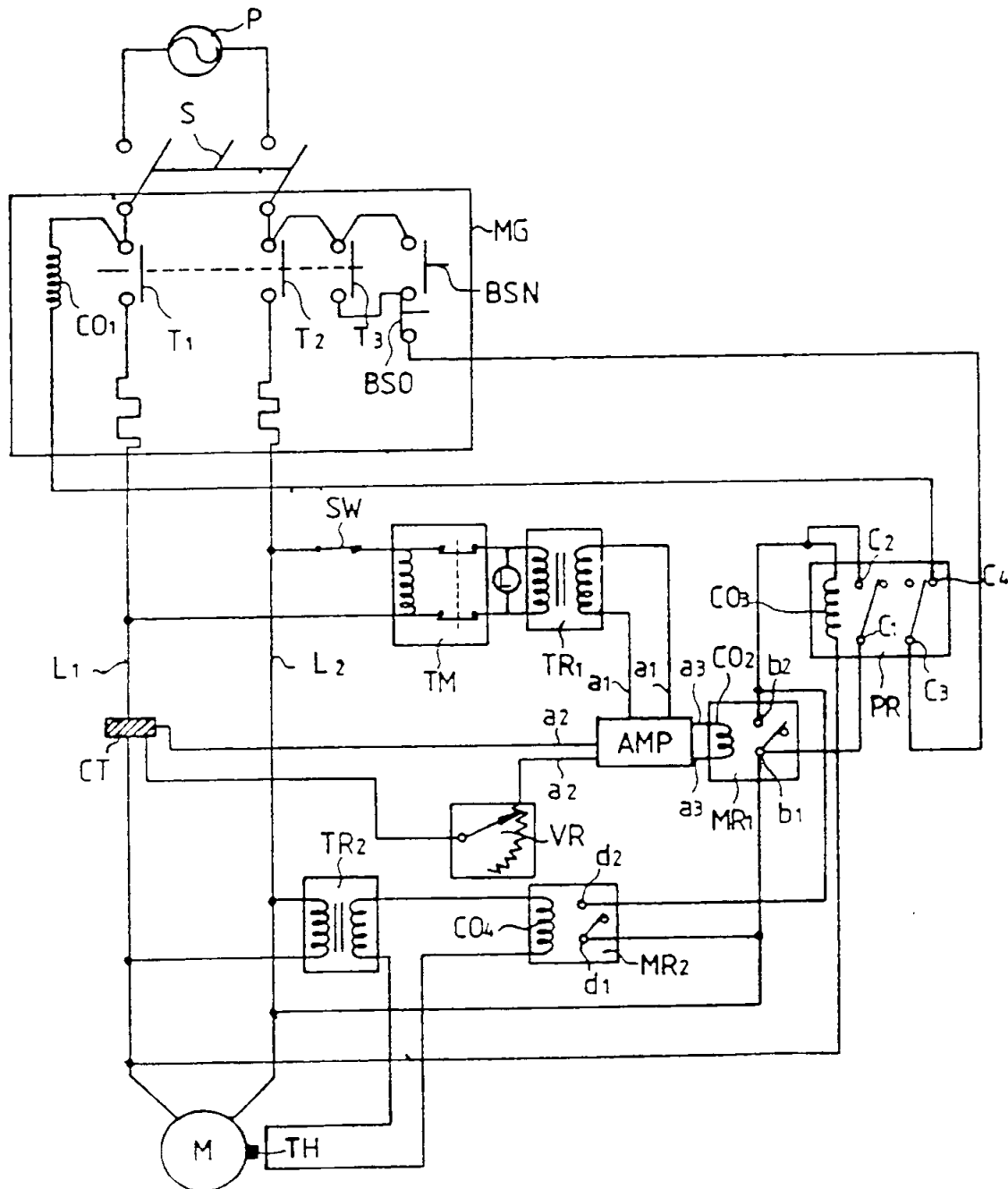


FIG. 1

TITLE

40308/wsd

Over Current Circuit Breaker

5 This invention relates to an over current circuit
breaker. Conventional over current circuit breakers are
normally set so as to cut off the power supply when the
electric current in an electric system exceeds a
predetermined level which is normally set at 1.5 to 2
10 times the rated capacity of the electric system.
However, if the electric system involves induction motors
then the system often draws a relatively large amount of
electric current normally regarded as a starting current,
which acts as a surge, at the start or within 15 to 20
15 seconds after the system is turned on. The starting
current is often as large as 5 to 9 times the rated
capacity of the system and would cause an over current
circuit breaker to trip if set at 1.5 to 2 times the
rated capacity of the system. Thus such a system will
20 never operate normally. If the over current circuit
breaker is set at a level to allow the system to draw the
starting current then the over current circuit breaker
will not trip when the system is overloaded or a short-
circuit takes place, and will thus fail to protect the
25 system from damage.

In view of the aforesaid problems with conventional over current circuit breakers, the present invention seeks to promote a new and improved over current circuit breaker which will not trip when the electric system is turned on but will trip when the system is overloaded or a short-circuit takes place.

According to this invention there is provided an over current circuit breaker which includes a main switch for turning on and turning off an electric system, a magnetic switch connected in series with the main switch, a power relay for operating the magnetic switch, a timer for producing a first control signal a predetermined time after the main switch is closed to turn on the electric system, a load detector for detecting the magnitude of the load of the electric system, an over current control device operable in association with the load detector for producing a second control signal when the load detector detects an over current drawn by the electric system, an amplifier operable by the first control signal in co-operation with the second control signal for producing a third control signal, a first microrelay operable by the third control signal for supplying power to the power relay to activate the power relay, which in turn causes the magnetic switch to trip.

In operation, the main switch and the

magnetic switch are manually closed to turn on the electric system. A predetermined time thereafter the timer produces a first control signal, the predetermined time being so selected to allow the electric system to operate from the starting point to the normal operating speed so that the starting current surge will have diminished when the first control signal is produced. When the electric system draws an excessive current, or when the system is overloaded, the over current control device then produces a second control signal which acts in co-operation with the first control signal to cause the amplifier to produce a third control signal. The third control signal then activates the first microrelay, which then activates the power relay, which then causes the magnetic switch to trip so as to turn off the electric system.

In a preferred embodiment a thermal detector is provided to detect the temperature of the electric system. When the temperature of the electric system reaches a predetermined level, the thermal detector produces a signal to activate a second microrelay which then activates the first microrelay to activate the power relay and the magnetic switch to cut off the power supply.

The invention is explained in more detail with

reference to the accompanying drawing disclosing an embodiment as example.

As shown in the circuit diagram of Figure 1, the over current circuit breaker of this invention includes a main switch S for supplying power from a power source P to an electric system M, a magnetic switch MG connected in series with main switch S, a power relay PR adapted to operate magnetic switch MG, a timer TM for producing a first control signal a predetermined time after main switch S and magnetic switch MG are closed to turn on electric system M, a load detector CT for detecting the magnitude of the load applied onto electric system M and producing a voltage, an over current control device VR for receiving the voltage from load detector CT and producing a second control signal when the load exceeds a predetermined level, an amplifier AMP operable by the first control signal in co-operation with the second control signal to produce a third control signal, a first microrelay MR1 operable by the third control signal, a power relay PR operable by first microrelay MR1 to cause magnetic switch MG to trip.

As shown in the drawing, timer TM is shunted between a pair of power supply lines L1 and L2 through a switch SW, timer TM having two output ends connected to a transformer TR1 which has a pair of output lines a1 - a1

connected to amplifier AMP. An indicator lamp L is shunted across the two output ends of timer TM. Timer TM is so set to produce a first control signal at the two output ends at a predetermined time, which may be 20 seconds for example, after the power is supplied to electric system M through the pair of power supply lines L1 and L2, and the first control signal is delivered to amplifier AMP through transformer TR1.

Load detector CT may be a coil which is adapted to produce a voltage in proportion to the load applied to electric system M. Over current control device VR, which may be a variable resistor, receives the voltage from load detector CT and produces a second control signal when the load applied to electric system M exceeds a predetermined level, which may be 1.5 times the rated capacity of electric system M. Load detector CT and over current control device VR are connected in series, and have a pair of common output lines a2 - a2 connected to amplifier AMP.

First microrelay MR1 has a solenoid CO2 shunted across two output terminals a3 - a3 of amplifier AMP, and a pair of contact points b1 - b2 shunted between two power supply lines L1 - L2 through a solenoid CO3 of power relay PR. Contact points b1 - b2 are normally open and will be closed when solenoid CO2 is energised.

Power relay PR has a first pair of contact points C1 - C2 which are normally open, and a second pair of contact points C3 - C4 which are normally closed. When solenoid CO3 is energised, first contact points C1 - C2 are caused to close to form a holding circuit (i.e. a by-pass) for solenoid CO3, and second contact points C3 - C4 are caused to open so as to de-energise solenoid CO1 of magnetic switch MG.

Magnetic switch MG has a first button switch BSN having two switches T1 - T2 connected to power supply lines L1 - L2, and another switch T3 connected in series with a second button switch BSO which is connected in series with second pair of contact points C3 - C4 of power relay PR and solenoid CO1 of magnetic switch MG.

In operation, main switch S is turned on manually and the first button switch BSN is pushed in by hand to close switches T1, T2 and T3. Since second contact points C3 - C4 of power relay PR are normally closed and second button switch BSO is also normally closed, solenoid CO1 is energised to hold switches T1 - T3 in a closed position, and at the same time power from power source P is supplied to electric system M through power supply lines L1 - L2. During a predetermined time, which may be 20 seconds, after the system M is turned on, timer TM remains inactive and therefore no signal will be

produced by timer TM. During this period a surge of electric current may occur in power supply lines L1 - L2 to cause load detector CT and over current control device VR to produce a second control signal to amplifier AMP; however, because of the absence of the first control signal from timer TM, amplifier AMP will not be activated, so that the electric surge is allowed to diminish within the predetermined time period and to allow electric system M to start until it operates at a rated capacity, or within a predetermined load level, and the second control signal signal from load detector CT and over current control device VR diminishes within the predetermined time period.

The predetermined period after starting, timer TM acts to produce a first control signal which is delivered to amplifier AMP through transformer TR1. However, at this time the second control signal from load detector CT and over current control device VR has already diminished, therefore amplifier AMP will not be activated.

When electric system M is overloaded or a short-circuit takes place during the operation, or when electric system M draws an excessive electric current, load detector CT and over current control device VR act to deliver a second control signal to amplifier AMP,

which is also receiving the first control signal from timer TM. Amplifier AMP is then activated to deliver a third control signal to energise solenoid CO2 of first microrelay MR1, and as a result contact points b1 - b2 are closed, so as to energise solenoid CO3 of power relay PR. Consequently first pair of contact points C1 - C2 of power relay PR is caused to close to form a holding circuit, and second pair of contact points C3 - C4 is caused to open, so as to de-energise solenoid CO1 of magnetic switch MG. As a result switches T1, T2 and T3 of magnetic switch MG are caused to open, or trip, so as to cut off the supply of power from power source P to electric system M.

The over current circuit breaker of this invention is optionally provided with an overheat protection device which includes a thermal detector TH for detecting the temperature of electric system M and delivering a temperature signal when the temperature of electric system M rises above a predetermined level, a second microrelay MR2 having solenoid CO4 to be energised by the temperature signal from thermal detector TH and a pair of contact points d1 - d2 which are normally open but will be closed when solenoid CO4 is energised. Contact points d1 - d2 are connected in parallel with contact points b1 - b2 of first microrelay MR1. A

transformer TR2 is provided to supply power from power supply lines L1 - L2 to thermal detector TH. When the temperature of electric system M rises above a predetermined level, thermal detector TH acts to deliver a temperature signal to activate second microrelay MR2 which then activates power relay PR, and consequently magnetic switch MG is caused to trip.

Although an over current circuit breaker for a signal-phase electric system has been illustrated, it is to be understood that the over current circuit breaker of this invention is readily applicable to a three-phase electric system.

Tests have been conducted to measure the response time of the over current circuit breaker of this invention to compare with a conventional over current circuit breaker, the tests reveal that the response time (that is the time lapsed from the time point the system is overloaded to the time point the over current circuit breaker "trips") of the over current circuit breaker of this invention is much shorter than that of the conventional over current circuit breaker.

Table 1

Tests for Reponse Time

HP of the System (220V) Tested	Current Rating (A)		Conventional Over Current Circuit Breaker			Present Over Current Circuit Breaker		
			1.5 x Rating	2 x Rating	3x Rating	1.5 x Rating	2 x Rating	3 x Rating
3HP	9	C	13.5	18	45	13.5	18	45
		T	10 min	4 min	45 sec	0.23sec	0.21sec	0.16sec
5HP	15	C	22.5	30	75	22.5	30	75
		T	10 min	4 min	45 sec	0.23sec	0.21sec	0.15sec
10HP	30	C	45	60	150	45	60	150
		T	10 min	4 min	45 sec	0.22sec	0.21sec	0.15sec

C: Current in ampere T: Response Time

CLAIMS

5 1. An over current circuit breaker comprising a main switch manually operable to turn on and turn off power from a power source to an electric system through power supply lines, a magnetic switch connected in series with said main switch, a timer for producing a first control signal a predetermined time after said electric system is energised, a load detector for detecting the magnitude of the load applied to said electric system, an over current control device for producing a second control signal when
10 said load detector detects a load that exceeds a predetermined level, an amplifier operable by said first control signal in co-operation with said second control signal to produce third control signal, and relay means
15 operable by said third control signal for causing said magnetic switch to open.

20 2. An over current circuit breaker as claimed in Claim 1, wherein said relay means comprises a first microrelay which is normally open but is closed when said third control signal is applied, and a power relay operable by said microrelay to de-energise and cause said magnetic switch to open.

3. An over current circuit breaker as claimed in Claim
1 or 2, further comprising a thermal detector for
producing a temperature signal when the temperature of
said electric system rises over a predetermined level,
and a second microrelay operable by said temperature
signal to activate said power relay, whereby said
magnetic switch is caused to open.

4. An over current circuit breaker substantially as
described herein and exemplified with reference to the
drawing.

5. An electric supply system incorporating a circuit
breaker in accordance with any preceding claim.

6. Electrical apparatus incorporating a circuit breaker
in accordance with any preceding claim.